

CLAIMS

1. Process for the production of thermoplastic vulcanizates, which comprises preparing a mixture of polymeric materials, including a matrix and a disperse phase component, and carrying out dynamic vulcanization of the disperse phase component, said dynamic vulcanization comprising the steps of grafting an organic silane on said disperse phase component, whereby to produce grafted disperse phase component chains, and cross-linking said disperse phase component chains in the presence of a cross-linking agent, said grafting and said cross-linking being carried out in the molten state of said disperse phase component.
2. Process according to claim 1, wherein the organic silane is an alkoxy silane.
3. Process according to claim 1, wherein the cross-linking agent is a functional compound, preferably polyfunctional compound having acid functionality, optionally in combination with an amine compound.
4. Process according to claim 3, wherein the cross-linking agent is chosen in the group consisting of boric acid and of combinations of adipic acid and an amine.
5. Process according to claim 4, wherein the amine of the combinations of adipic acid and an amine is triisopropanol amine or triethanol amine.
6. Process according to claim 1, wherein the dynamic vulcanization is carried out in batch mode.
7. Process according to claim 1, wherein the dynamic vulcanization is carried out in continuous mode.

8. Process according to claim 1, wherein the matrix material is a semi-crystalline polymer.
9. Process according to claim 1, wherein the matrix material is an amorphous polymer.
10. Process according to claim 8, wherein the semi-crystalline polymer is chosen in the group consisting of thermoplastic polyesters, polyacetals, polyvynilidene fluoride (PVDF), polycarbonate, polystyrene and styrene copolymers, crystalline polyethylene, ethylene copolymers, polypropylene homopolymer, propylene-ethylene random copolymer, heterophasic propylene-ethylene copolymer, and polyamides.
11. Process according to claim 1, wherein the matrix polymer is in the amount of 15 to 80 wt% of the total polymeric composition.
12. Process according to claim 1, wherein the disperse phase component is chosen in the group consisting of polyethylene having density in the range 0.90 – 0.96 g/cm<sup>3</sup>, ethylene-alpha-olefin copolymers having density in the range 0.85 – 0.95 g/cm<sup>3</sup>, ethylene copolymers with vinyl acetate or acrylate or other polar monomers, chlorinated polyethylene, styrene block copolymers, natural rubber, polybutadiene, nitrile rubber, butadiene-styrene rubber, nitrile rubber, chloroprene rubbers, butyl rubber, hydrogenated rubbers, and blends thereof.
13. Process according to claim 1, wherein the disperse phase component is in the amount of 20 to 85 wt% of the total polymeric composition.
14. Process according to claim 1, wherein the cross-linking agent is in the amount of 0.05 to 5 parts per 100 parts of the total polymeric composition.

15. Process according to claim 1, further comprising adding to the thermoplastic vulcanizate, at any convenient stage of the preparation thereof, one or more additional components chosen from the group consisting of antioxidants, plasticizers, mineral fillers and functional components, and additional polymer components selected from crystalline or amorphous polymers, elastomers, and grafted polymers.
16. Process according to claim 1, wherein the matrix is not cross-linkable.
17. Process according to claim 1, wherein the disperse phase component has a melting point lower than the melting point of the matrix and the grafting is carried out at temperatures between the melting point of the matrix and the melting point of the disperse phase component.
18. Process according to claim 1, wherein the grafting is carried out at temperatures at which all the polymeric components are molten.
19. Process according to claim 1, further comprising removing any residues of the volatile components by venting or vacuum after the grafting stage has ended.
20. Process according to claim 6, wherein the grafting and the cross-linking are carried out successively.
21. Process according to claim 6, wherein the grafting and the cross-linking are carried out in different zones of the barrel of an extruder.
22. Process according to claim 6, comprising the steps of:
  - a) mixing the disperse phase component and at least part of the matrix with the chosen silane, free radicals, free radical generators and optionally tin-organic compounds;
  - b) bringing the mixture of the aforesaid components to the grafting

- temperature;
- c) allowing the grafting to take place;
  - d) after the grafting, raising the temperature of the mixture to at least the melting point of the matrix, and the cross-linking agent and antioxidant;
  - e) allowing the cross-linking to occur, whereby phase inversion occurs;
  - f) optionally, devolatilizing the resulting product;
  - g) adding any required additional components, while mixing; and
  - h) discharging the final product.
23. Process according to claim 7, comprising the steps of:
- a) feeding at least part of the matrix and all other polymeric components to the feed hopper of an extruder;
  - b) feeding silane and peroxide to a feeding zone of the extruder, while cooling said zone;
  - c) heating the grafting zone of the extruder to such a temperature as to melt the disperse phase component without melting the matrix;
  - d) kneading the resulting mixture;
  - e) feeding an additional feeder zone of the extruder the additives needed for causing cross-linking, including cross-linking agents and antioxidants;
  - f) if necessary, completing the feeding of the matrix;
  - g) mixing and kneading the mixture of the fed components, while heating;
  - h) removing the volatiles;
  - i) optionally adding extender oil and mixing; and
  - k) extruding the resulting product.
24. Thermoplastic vulcanizates, comprising a matrix and a cross-linked disperse phase, which are thermodynamically incompatible, said vulcanizates having the following properties:
- a) low rigidity;

- b) high flexibility measured by low Shore hardness between 25A and 60D;
  - c) disperse phase content of at least 50% by volume;
  - d) high gel content of the vulcanized disperse phase component;
  - e) high cross-link density of the vulcanized disperse phase component;
  - f) white color;
  - g) non-hygroscopicity;
  - h) lack of toxic components; and
  - i) narrow gaps (ligaments) between cross-linked disperse phase particles, providing near-continuity of said particles within the matrix.
25. Thermoplastic vulcanizates, comprising a matrix and a cross-linked disperse phase, which are thermodynamically incompatible, said vulcanizates having the following properties:
- a) low or medium rigidity;
  - b) disperse phase content of at least 50% by volume;
  - c) high gel content of the vulcanized disperse phase component;
  - d) high cross-link density of the vulcanized disperse phase component of more than  $5 \cdot 10^{-5}$  mol/cm<sup>3</sup>;
  - e) white color;
  - f) non-hygroscopicity;
  - g) lack of toxic components;
  - h) excellent processability by techniques used for processing thermoplastics, comprising extrusion, molding, thermoforming, blow molding, calendering;
  - i) very good impact resistance at room temperature and below 0°C; and
  - k) high melt elasticity and melt strength.
26. Thermoplastic vulcanizates according to claims 24 and 25, wherein the matrix consists of semi-crystalline polymers or amorphous polymers.

27. Thermoplastic vulcanizates according to claims 24 and 25, wherein the semi-crystalline polymers are chosen in the group consisting of thermoplastic polyesters, polyacetals, polyvinylidene fluoride (PVDF), polycarbonate, polystyrene and styrene copolymers, crystalline polyethylene, ethylene copolymers, polypropylene homopolymer, propylene-ethylene random copolymer, heterophasic propylene-ethylene copolymer and polyamides.
28. Thermoplastic vulcanizates according to claims 24 and 25, wherein the content of matrix is 15 to 80 wt% of the total vulcanizate.
29. Thermoplastic vulcanizates according to claim 24 and 25, wherein the cross-linked disperse phase is chosen from the group consisting of polyethylene having density in the range 0.90 – 0.96 g/cm<sup>3</sup>, ethylene-alpha-olefin copolymers having density in the range 0.85 – 0.95 g/cm<sup>3</sup>, ethylene copolymers with vinyl acetate or acrylate or other polar monomers; chlorinated polyethylene, styrene block copolymers, natural rubber, polybutadiene, nitrile rubber, butadiene-styrene rubber, chloroprene rubbers, butyl rubber, hydrogenated rubbers, and blends thereof.
30. Thermoplastic vulcanizates according to claims 24 and 25, wherein the content of the disperse phase is 20 to 85 wt% of the total vulcanizate.
31. Products made from the thermoplastic vulcanizates of any one of claims 24 to 30, by known processing techniques, including extrusion, injection molding, thermifforming, blow molding and calendering.